WeBIOPATR2011

THE THIRD INTERNATIONAL WeBIOPATR
WORKSHOP & CONFERENCE
PARTICULATE MATTER: RESEARCH AND MANAGEMENT

ABSTRACTS OF KEYNOTE INVITED LECTURES AND CONTRIBUTED PAPERS

Editors
Alena Bartonova and Milena Jovašević-Stojanović

Public Health Institute of Belgrade

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- *sources and formation of particulate matter*
- *particulate matter composition*
- *environmental modeling*
- *particulate matter indoors*
- *nanoparticles in the environment*

PARTICULATE MATTER AND HEALTH

- *exposure to particulate matter*
- *health aspects of atmospheric particulate matter*
- *assessment of risks and health effects*
- *full chain approach*

PARTICULATE MATTER AND REGULATORY ISSUES

- *issues related to monitoring of particulate matter*
- *legislative aspects*
- *abatement strategies*

SPECIAL SESSION – GRADUATE STUDENTS

For PhD and MSc students to discuss their work related to particulate matter

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INVESTIGATION OF REGIONAL TRANSPORT AND HEALTH RISK EFFECTS OF METALS IN $PM_{2.5}$ AIR PARTICULATE MATTER IN BELGRADE

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Airborne particles with aerodynamic diameter less than 2.5 μm ($PM_{2.5}$) penetrate deep into the respiratory system and pose a health concern. These particles contain toxic metals, which can accumulate in the human body and exert additional health problems. Thus, there is a need for monitoring the $PM_{2.5}$ concentration and their metal content.

This paper aims to present the results of comprehensive research of regional transport and health risk effects of metals in $PM_{2.5}$ sampled in the Belgrade urban area. Daily average mass concentrations of $PM_{2.5}$ were taken in episode measurements from July 2003 to December 2006 in Belgrade. The measurements were performed using Mini-Vol air samplers (Airmetrics Co., Inc.; 5 l min^{-1} flow rate) provided with a $PM_{2.5}$ cutoff inlet. Particle mass was determined by gravimetric analysis, and the concentrations of ten elements (Al, Cd, Cr, Cu, Fe, Mn, Ni, Pb, V and Zn) in the $PM_{2.5}$ samples were determined by atomic absorption spectrometry (AAS). The results show that the Fe is the most abundant metal (1627 ng m^{-3}) followed by Al (901 ng m^{-3}), Zn (943,6 ng m^{-3}), Cu (44,7 ng m^{-3}), Mn (18,3 ng m^{-3}), Pb (43,7 ng m^{-3}), V (71,4 ng m^{-3}), Ni (29,2 ng m^{-3}), Cr (4,4 ng m^{-3}) and Cd (1,5 ng m^{-3}). The size distribution, morphology and chemical composition of suspended particles were analyzed using Scanning Electron Microscopy (SEM) coupled with Energy-Dispersive X-ray analysis (EDX) to aid source identification of collected particles.

Processes in the atmosphere represent a complex problem due to the simultaneous influence of several independent factors (meteorological conditions, pollutant emission level, topography) and thus the environmental data are random variables that follow natural lognormal distribution. Deviation from lognormal distribution of atmospheric aerosols is a positive indicator of possible transport processes. Therefore, in this study the quantiles for ten heavy metals in $PM_{2.5}$ samples were analyzed by the quantile-quantile P-P slope test. This is used for fitting the quantiles of the expected theoretical cumulative probability for normal, lognormal and Weibull distribution with the quantiles of the cumulative probabilities calculated for the experimental dataset. The results show that the Weibull distribution is the most appropriate for Pb, V, Ni and Cr suggesting their possible regional transport. In order to identify possible source locations for these metals in $PM_{2.5}$ measured at the receptor site, two hybrid receptor models Potential Source Contribution Function (PSCF) and Concentration Weighted Trajectory (CWT) were used. PSCF model provides a map of source potential of geographical areas while CWT distinguishes major sources from moderate ones by calculating concentration gradients. The results indicate possible significant transport from north-west and east region for Pb and north and south-west for V and Ni. Potential source emissions for Cr are mainly distributed in south region.

The health risk assessment caused by the heavy metal content of the $PM_{2.5}$ particles in Belgrade was conducted using the US EPA health risk assessment model. For that purpose, incremental lifetime cancer risk (ILCR) has been calculated for Cd, Cr, Ni, and Pb, the elements which are human carcinogens. The obtained values indicate low cancer risk. In order to estimate non-cancer effects of analyzed heavy metals, the corresponding hazard quotients were calculated. These quotients do not exceed the nominal value 1, suggesting that the analyzed metals are not likely to cause adverse health effects.

RECEPTOR MODELING STUDIES FOR THE CHARACTERIZATION OF PM_{10} POLLUTION SOURCES IN BELGRADE

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Atmospheric aerosols have a confirmed role in climate change and radiative budget, impact on human health, effects on ecosystems and local visibility. Previous epidemiological studies indicated statistical associations between mortality and ambient concentrations of particulate matter (PM), particularly fine particles that can more readily penetrate into the lungs and are therefore more likely to increase the incidence of respiratory and cardiovascular disease. One of the main difficulties in air pollution management is to determine the quantitative relationship between ambient air quality and pollutant sources. Source apportionment is the process of identification of aerosols emission sources and quantification of their contribution to the aerosol mass and composition. Identification of pollutant sources is the first step in the process of devising effective strategies to control pollutants. Various receptor models have been used to identify aerosol sources and estimate their contributions to PM_{10} (particles less than 10 μm in diameter) concentrations at receptor sites and downwind areas in Europe.

In this study, the Unmix model has been used to analyze the three years (2003-2006) PM_{10} data set for source apportionment purpose in Belgrade. Suspended PM_{10} particles were collected on preconditioned and pre-weighed Pure Teflon and Teflon-coated Quartz filters (Whatman, 47 mm diameter, 2 μm pore size) using MiniVol air sampler provided with PM_{10} cutoff inlets. The elemental composition (Al, V, Cr, Mn, Fe, Ni, Cu, Zn, Cd and Pb) of the PM_{10} samples was determined by the atomic absorption spectroscopy method (AAS). Unmix resolved four sources related to resuspended road dust, fossil fuel combustion, traffic exhaust and regional transport mainly from steel and petrochemical industry. In addition, the average source contributions as well as the seasonal variability of the identified sources were also examined. To estimate the local source impacts from various wind directions, the Conditional Probability Function (CPF) was performed for each source using the source contributions estimated from the Unmix coupled with the surface wind direction data.

Hybrid receptor models Potential Source Contribution Function (PSCF) and Concentration Weighted Trajectory (CWT) were used for identification of source regions. The PSCF values can be interpreted as a conditional probability describing the spatial distribution of probable geographical source locations inferred by using trajectories arriving at the sampling site. Since the PSCF method is known to have difficulties distinguishing strong sources from moderate sources, the CWT model that determines the relative significance of potential sources has been additionally performed. To estimate the likely source locations for regional transporting aerosols, the PSCF and CWT were calculated using the daily source contributions to PM_{10} concentration deduced from the Unmix and backward trajectories. Air masses back trajectories were computed by the HYSPLIT (HYbrid Single Particle Lagrangian Integrated Trajectory) model through interactive READY system. Daily 48-h back trajectories, started from Belgrade (44.804o, 20.478o) at 12:00 UTC each day, were evaluated for six different heights above the starting point at ground level (200, 350, 500, 750, 1000 and 1200 m). The impact of transported particulate matter on air quality and human health is considered to be significant at receptor areas. In addition, a study of airflow characteristics was performed using cluster analysis of 48-hour backward trajectories of air masses arriving above Belgrade. Airflow directions were grouped into six classes indicating typical origin of air masses. The results suggest that highest PM_{10} concentrations were related to the west-southwest and south pathways.

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